



Chemical traits of pigeonpea (*Cajanus cajan*) pod wall affecting pod fly (*Melanagromyza obtusa*) damage

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ABSTRACT

Pigeonpea (*Cajanus cajan* (L.) Millsp.) is the second important pulse crop in India. Pod fly [*Melanagromyza obtusa* (Malloch)] is a major pest of long-duration pigeonpea in India. The grain damage caused by this insect pest varies from 20 to 80%. The concealed mode of life of pod fly within the pod makes it difficult to control, with chemical insecticides. Therefore, host-plant resistance is an important tool for the management of this pest. Analysis of pod walls of five pod fly resistant/tolerant and six susceptible cultivars/genotypes showed that the genotypes with more wax, total phenols and less reducing and non-reducing sugars and total amino acids suffered less pod and grain damage by pod fly. Therefore, these biochemical pod traits can be used as marker to identify the resistance sources to be used in breeding programme.

Key words: *Melanagromyza obtusa*, Phenols, Pigeonpea, Reducing sugar, Wax

The pigeonpea yield has become stagnant over last four decades, largely because of insect pest damage. Out of 250 insect species feeding on pigeonpea from germination to harvest, *M. obtusa* is one of the important pest affecting yield globally. The losses due to pod fly damage have been estimated to the tune of US \$ 256 million annually (Anonymous 1992).

India contributes about 25% to world pulse production. Pigeonpea, *Cajanus cajan* (L.) Millsp ranks second and contributes about 18% in total pulse production of India. The tur pod fly [*Melanagromyza obtusa* (Malloch)] is the most important insect pest of long-duration pigeonpea, particularly in Uttar Pradesh, Bihar and Madhya Pradesh. In these states much of the pigeonpea grown is of long duration and tur pod fly causes 20 to 80% grain damage. Field surveys carried out in Uttar Pradesh during 1978–84 revealed 24.6% grain damage by *M. obtusa* on long duration varieties like T₇ and T₁₇.

The female pod fly oviposites individually in the developing pods. The pod fly infested pods do not show any external symptom of damage until the fully-grown larvae chew the pod wall, leaving a thin papery membrane intact called as window, through which adults exit the pods. The

white maggots feed on the developing grain and pupate inside the pod. The pod fly damaged grains do not germinate and are unfit for human consumption also.

The pod fly attack remains unnoticed by the farmers owing to the concealed mode of life and thus it becomes difficult to manage. The identification and development of pod fly-resistant cultivars/genotypes would provide an equitable and environmentally sound tool for the sustainable management of this difficult to control insect pest. The oviposition of pod fly takes place on the inner surface of the pod walls of green pods and the ovipositional behaviour of the pod fly has revealed that morphological, anatomical and biochemical characters/constituents of pod walls affect the ovipositional behaviour. Therefore, present investigations were carried to work out the biochemical basis of resistance in pigeonpea pod walls to pod fly in long duration pigeonpea very specifically.

MATERIALS AND METHODS

The experimental material consisted of five pod fly-resistant/tolerant and six pod fly-susceptible genotypes of long duration maturity group. The sowing was done at Agricultural Research Farm (Pigeonpea Entomology Block), BHU on 13 July and 16 July during 2006 and 2007 cropping seasons, respectively. There were four replications in a randomized block design. Each plot was of 5 rows of 4m and row-to-row and plant-to-plant distance was maintained as 75 and 30 cm respectively. The crop was grown by following the normal agronomic practices and no insecticide was applied

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in experimental plots.

After 80% maturity of the crop both healthy and damaged pods were collected from five randomly selected plants from central three rows of each genotype from all the three replications to estimate the pod and grain damage by *M. obtusa* during 2006–07 and 2007–08 cropping seasons. Total number of pods and grain and pod fly damaged pods and grains were counted separately, and the data was expressed as per cent pod and grain damage.

The resistance and susceptibility of the selected genotypes/cultivars of long duration, which were earlier tested under AICRP on Pigeonpea was reconfirmed in 2006–07. After reconfirmation, the analysis of biochemical constituents of pod walls of these genotypes was done in 2007–08 and the susceptibility of these genotypes against *M. obtusa* was again recorded in the field in 2007–08.

The green pods (30 days after opening of the flowers) were collected from each genotypes to obtain pod wall for biochemical estimations. The pod walls were dried in an oven at 60°C for 2–3 days. The dried samples were ground in an electric blender. The ground samples were kept in a paper envelop in oven at 50°C for 1 day to ensure complete drying of the samples. The completely dry samples were then used for the estimation of bio-chemical constituents. The phenol, reducing and non-reducing sugars were estimated by using the method of Malik and Singh (1980). Total amino acid was estimated by the method of Lee and Takahashi (1966). The wax content was estimated by the method of Martin and Batt (1968).

Data were subjected to analysis of variance. The significance of differences between the treatments was evaluated by F-test and least significance difference (LSD) at $P=0.05$.

RESULTS AND DISCUSSION

Evaluation for Melanagromyza obtusa damage

There were significant differences in per cent pod and grain damage by pod fly in various genotypes during both the years of experimentation (Table 1).

During 2006–07, per cent pod and grain damage by pod fly ranged from 14.7 to 37.0% and 9.0 to 25.0%, respectively. The pod damage on the five resistant/tolerant genotypes, which were earlier tested under AICRP on pigeonpea ranged between 14.7% on PDA 88-2E and 21.1% on MA3, whereas on the remaining six susceptible genotypes, it ranged from 30.4% on MA24 to 37.0% on Bahar. The grain damage on five resistant/susceptible genotypes ranged from 9.0% on PDA 88-2E to 14.6% on MA3, whereas in the so called susceptible genotypes, it ranged from 20.8% on MA 24 to 25.0% on Bahar.

Similarly in 2007–08, the per cent pod and grain damage by pod fly ranged from 16.7 to 41.6% and 11.3 to 30.2%, respectively. The pod damage on the five resistant/tolerant genotypes, ranged from 16.7% on PDA 88-2E to 23.4% on

Table 1 Susceptibility of some pigeonpea genotypes/cultivars to pod fly infestation

Genotype	Per cent pod damage by pod fly		Per cent grain damage by pod fly	
	2006–07	2007–08	2006–07	2007–08
PDA 88-2E	06.4 (14.7)*	08.3 (16.7)	02.5 (9.00)	03.9 (11.3)
PDA 89-2E	07.3 (15.7)	09.3 (17.8)	02.8 (9.60)	04.5 (12.2)
PDA 87-3E	08.5 (17.0)	10.0 (18.4)	02.8 (9.60)	04.8 (12.6)
PDA 85-5E	11.9 (20.2)	13.3 (21.4)	04.7 (12.5)	04.9 (12.8)
MA 3	12.9 (21.1)	15.8 (23.4)	06.4 (14.6)	05.6 (13.7)
MA 24	25.6 (30.4)	30.3 (33.4)	12.6 (20.8)	18.0 (25.1)
MA 20	27.4 (31.6)	33.5 (35.4)	11.8 (20.0)	21.3 (27.5)
MA 6	32.2 (34.6)	38.9 (38.6)	12.8 (21.0)	22.6 (28.4)
MA 13	34.6 (36.1)	42.0 (40.4)	15.4 (23.1)	23.3 (28.9)
Bahar	36.2 (37.0)	44.1 (41.6)	17.8 (25.0)	25.3 (30.2)
SEm ±	(1.21)	(1.3)	(0.93)	(0.74)
CD $P=0.05$	(4.2)	(4.5)	(3.2)	(2.6)

* Arc sine transformed values

MA3, whereas on the remaining six susceptible genotypes, it ranged from 33.4% on MA24 to 41.6% on Bahar. The grain damage on five resistant / susceptible genotypes ranged from 11.3% on PDA 88-2E to 13.7% on MA3, whereas on the susceptible genotypes, it ranged from 25.1% on MA 24 to 30.2% on Bahar. The results of both the years are in conformity with the finding of Srivastava *et al.* 1994.

Influence of bio-chemical traits of pigeonpea pod wall on incidence of M. obtusa

There were significant differences in wax content, total phenols, total amino acids, reducing and non-reducing sugars of green pod walls of various genotypes (Table 2).

The total wax content in the pod walls of resistant genotypes were significantly higher and ranged between 4.76 % in PDA 88-2E and 3.38 % in MA3 and in susceptible genotypes the corresponding values were lower and varied from 2.82 % in MAL 24 to 2.16 % in Bahar. Das and Odak (1987) have also reported negative correlation between wax content and pod fly infestation on pigeonpea.

The total phenols in the pod walls of pod fly resistant/tolerant genotypes were significantly higher (19.49 mg/g in PDA 88-2E to 16.24 mg/g in MA3) and in susceptible genotypes it ranged between 14.27 mg/g in MA-24 and 13.04 mg/g in Bahar. This result is in conformity with the

Table 2 Biochemical traits of green pods of different pigeonpea genotypes/cultivars

Genotype	Wax content (%)	Total phenols (mg/g)	Reducing sugars (mg/g)	Non-reducing sugars (mg/g)	Total amino acids (mg/g)
PDA 88-2E	4.76	19.49	8.80	14.95	1.12
PDA 89-2E	4.35	17.61	9.85	16.77	1.27
PDA 87-3E	3.48	17.46	10.32	17.55	1.41
PDA 85-5E	3.32	16.44	11.37	19.37	1.71
MA 3	3.38	16.24	13.67	23.29	2.20
MA 24	2.82	14.27	15.31	26.16	2.42
MA 20	2.60	13.20	17.36	29.41	2.65
MA 6	2.46	13.03	17.77	30.10	2.76
MA 13	2.37	13.01	17.80	30.15	2.80
Bahar	2.16	13.01	18.31	31.08	4.04
SEm \pm	0.50	0.78	2.06	3.01	0.25
CD ($P= 0.05$)	1.46	2.28	6.05	10.28	0.72

findings of Moudgal *et al.* (2008) that the total phenols in the pod walls of pod-fly resistant pigeonpea genotypes of extra early and early group were significantly more than that in susceptible genotypes. It is in conformity with the present findings. The expression of resistance to *H. armigera* in wild relatives of pigeonpea has been reported to be associated with high amounts of polyphenols (Sharma *et al.* 2009). Sunitha *et al.* (2008) reported that high phenol concentration in flowers and pods of short-duration pigeonpea was responsible for resistance against *M. vitrata*.

The reducing sugars were significantly higher in susceptible genotypes (18.31mg/g in Bahar to 15.31 mg/g in green pod walls of MA 24) and in resistant genotypes these values were significantly lower (8.80 mg/g in PDA 88-2E to 13.67 mg/g in MA3). In early and extra early pigeonpea varieties, Moudgal *et al.* (2008) reported that the reducing sugars in pod walls of pod fly susceptible genotypes were significantly higher than the resistant group of genotypes across plant type and maturity groups. Expression of resistance to *H. armigera* has been reported to be associated with low amounts of sugar in wild relatives of pigeonpea (Sharma *et al.* 2009). High sugar content in flowers and pods of short-duration pigeonpea was responsible for susceptibility against *M. vitrata* (Sunitha *et al.* 2008).

The non-reducing sugars were significantly higher in susceptible genotypes (31.08 mg/g in Bahar to 26.16 mg/g in green pod walls of MA 24) and in resistant genotypes these values were significantly lower (14.95 mg/g in PDA 88-2E to 23.29 mg/g in MA3). Das and Odak (1987) have found a positive correlation with linear relationship between pod infestation by pod fly and non-reducing sugars content. They have worked out a regression equation which shows that with every increase of 1% infestation, there was an increase of 0.32 mg of non-reducing sugars per gram of sample. In early and extra early pigeonpea varieties, Moudgal *et al.* (2008) reported negative relationship between pod and grain damage by pod fly and non-reducing sugars.

The total amino acids were found to be positively associated with the pod fly infestation on long-duration pigeonpea. The total amino acids in the pod walls of pod fly resistant genotypes were significantly lower (1.12 mg/g in PDA 88-2E to 2.20 mg/g in MA3) and in susceptible genotypes it ranged between 4.04 mg/g in Bahar and 2.42 mg/g in MA-24. Moudgal *et al.* (2008) reported that protein content in the pod walls of pigeonpea genotypes were significantly and positively associated with the susceptibility to pod fly damage in short and extra short duration genotypes. Das and Odak (1987) reported negative correlation between total amino acids and pod fly infestation but the relationship was not linear.

Certain chemicals are produced by the plants in varying quantities and proportions, which affect the behaviour of phytophagous insects in various ways. These chemical compounds determine the feeding and food selection of the herbivores. The pod wall biochemical traits have earlier been reported to play an important role in pigeonpea for resistance to insects (Moudgal *et al.* 2008). Present investigation clearly suggested that pigeonpea pod walls with more wax, total phenols and less reducing and non-reducing sugars and total amino acids suffered less pod and grain damage by pod fly in pigeonpea. Therefore, these biochemical pod traits can be used as marker to identify the resistance sources of pigeonpea with different mechanism of resistance against pod fly. This finding can be used very effectively in pod fly-resistant breeding programme.

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